-ORIGINAL LETTER SENT TO FILE-

Kennecott Utah Copper Corporation
8315 West 3595 South
P.O. Box 6001
Magna, Utah 84044-6001
(801) 252-3000

M/035/002
NROC

Kennecott

April 10, 2001

Tom Munson
Utah Department of Natural Resources
Department of Oil, Gas, and Mining
1594 West North Temple, Suite 1210
P.O. Box 14581
Salt Lake City, UT. 84114-5801

Re: KUCC South Facilities Groundwater Draft Remedial Design Work Plan

Dear Mr. Munson,

As discussed at the last TRC meeting on February 20, 2001, KUCC submits the attached South Facilities Groundwater Draft Remedial Design Work Plan to the TRC for review and comment. Please review the attached Work Plan and provide any comments to me by Friday May 4, 2001. KUCC will address comments received and reissue a final Work Plan by May 18, 2001. If you have any questions regarding the Work Plan, please contact me at 801-252-3126 or email at cherryj@kennecott.com.

Sincerely,

Jon Cherry

Jon Cherry, P.E.
Senior Project Engineer

JCC

Attachment

File in:
☐ Confidential
☐ Shelf
☒ Expandable
Refer to Record No 0009 Date 4/12/2001
In M/035/002, 2001, Incoming
For additional information

RECEIVED
APR 12 2001
DIVISION OF
OIL, GAS AND MINING

M/035/002

KENNECOTT UTAH COPPER

Draft
South Facilities Groundwater
Remedial Design Work Plan

Prepared By: Kennecott Utah Copper
Date: April 6, 2001
Version B

KENNECOTT UTAH COPPER
SOUTH FACILITIES GROUNDWATER
REMEDIAL DESIGN WORK PLAN

DRAFT

Prepared by: Kennecott Utah Copper Corporation

Date: April 6, 2001

Table of Content

List of Tables

List of Figures

List of Attachments

1.0 INTRODUCTION

1.1 Purpose of Remedial Design Work Plan

This Work Plan sets out the technical basis, plans and schedules by which Kennecott Utah Copper Corporation (KUCC) will prepare a Final Remedial Design to address groundwater contamination at KUCC's South Facilities in accordance with the U.S. Environmental Protection Agency's Record of Decision. The Remedial Design, which addresses the size, scope and character of the Remedial Action, will:

- describe the problems to be addressed
- identify the technical requirements to complete a successful remedial action
- establish performance-based criteria for the components of the remedy
- report the results of design investigations and support activities needed to finalize engineering plan
- present the engineering plans and specifications that implement the performance criteria
- document monitoring programs that will be implemented during and following remedial actions
- provide schedules for implementing the remedial action.

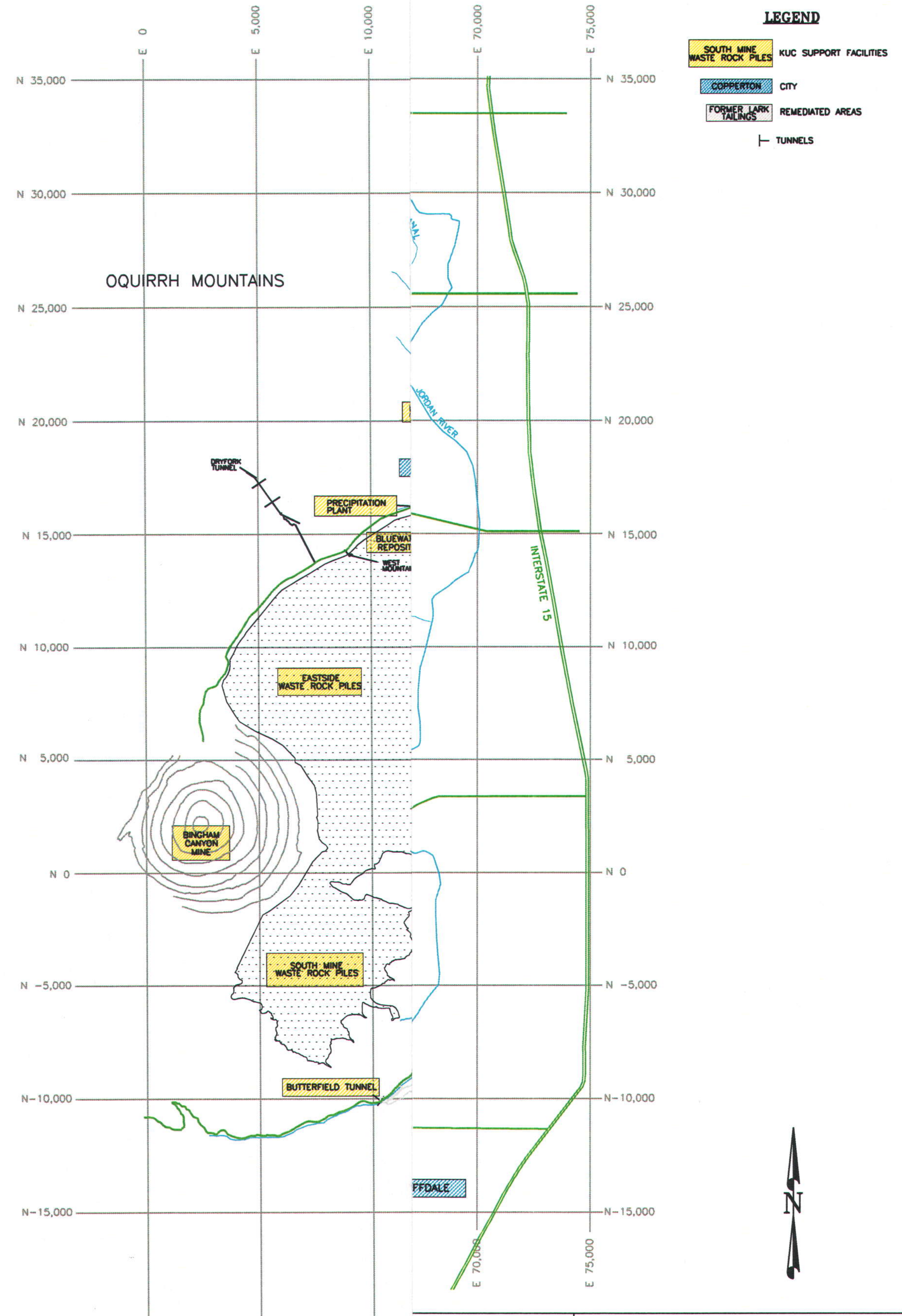
1.2 Site Description And Background

1.2.1 Study Area

The southwest Jordan Valley (SWJV) extends from the KUCC waste rock disposal areas on the eastern edge of the Oquirrh Mountains to the Jordan River. The foothills of the Traverse Mountains bound it on the south; the northern boundary is at approximately 7800 South Street. Figure 1-1 shows the project study area.

1.2.2 Site Description

The Bingham Canyon mine is located on the western edge of the SWJV in the Oquirrh Mountains. The open-pit mine covers 1,900 acres and is over one-half mile deep. More than five billion tons of rock have been removed from the pit, resulting in the production of more than 15 million tons of copper and other metals. Waste rock from the mine is placed along the east, west and north sides of the pit, where it is naturally leached by meteoric water. Prior to 2000, the waste rock was artificially leached with recycled acidic water. The active leaching circuit was discontinued on September 29, 2000.



NVIRONMENTAL
EERING SERVICES

= 6500'

	DATE
L	5/27/99
C	5/27/99
L	4/2/01
	4/4/01
	4/4/01

KENNECOTT
UTAH COPPER

FIGURE 1-1
RI/FS AND RDWP
STUDY AREA

Job No. --- Dwg. No. 451-T-5100 REV 3 DATE 4/4/01

N:\451\451T5101 04/04/01 11:29 kmcook

1.3 Summary of Site Characteristics

This section summarizes the regional and site-specific geography, geology and hydrogeology as interpreted from previous site characterization studies and the RI field program. These topics are discussed in more detail in the RI report (KUC 1998a) and the FS report (1998b), which also include numerous figures and tables that document and elaborate the following discussion.

1.3.1 Geographic Setting

From the Oquirrh foothills to the Jordan River, the topography is of moderately low relief. Elevations of topographic features in the region range from 4,300 ft above mean sea level (amsl) at the Jordan River, 5,300 ft amsl along the foothills of the Oquirrh Mountains, to 9,000 ft amsl or more in the Oquirrh Mountains. The Jordan River enters the Jordan Valley through a gap in the Traverse Mountains referred to as the Jordan Narrows, and flows northward through the valley to the Great Salt Lake.

1.3.2 Meteorology

Climate. A wide range of temperatures, which are strongly influenced by altitude and topography, characterizes the climate of the Jordan Valley. Mean annual precipitation in the Jordan Valley is about 13 to 14 inches (Hely et al. 1971). Annual precipitation in the Oquirrh Mountains ranges from 20 to 40 inches, with the Bingham Canyon mine receiving an average of about 25 inches. Estimated annual potential evapotranspiration in the Oquirrh Mountains ranges from 21 to 27 inches, and in the Jordan Valley from 24 to 30 inches (Hely et al. 1971).

Surface Water Hydrology. The principal surface water in the SWJV is found in the Jordan River, Butterfield and Bingham creeks, and irrigation canals. Surface water recharge to the Jordan River consists of effluent from several sewage treatment plants, inflow from major tributaries, agricultural return flow to canals, and storm water and non-point-source runoff from numerous and various sources. North of the Jordan Narrows, groundwater inflow is the principal source of recharge to the Jordan River (Hely et al. 1971).

Butterfield and Bingham creeks are both intermittent, losing streams along their respective reaches in the basin fill of the SWJV (Dames & Moore 1988). Historically, the lower reaches of Butterfield and Bingham creeks have flowed only during peak runoff or major storm events, and have rarely reached the Jordan River. Butterfield Creek, which is the only stream in the area that is gauged, flowed at an average rate of 3.15 cubic feet per second (cfs) at the mouth of Butterfield Canyon between February 1998 and April 1999. The Herriman Irrigation Company uses the water from Butterfield Creek for irrigation. Surface water resulting from storm-water runoff in upper Bingham Creek is captured at the mouth of the canyon and used by KUCC in its process.

Four unlined irrigation canals (Provo Reservoir, Utah Lake Distributing, Utah and Salt Lake, and South Jordan) cross the eastern part of the SWJV. Water from these canals is used for irrigation and the latter three canals contain water only during the irrigation season. The Jordan River and Utah Lake are the source of water for all the canals except for the Provo Reservoir Canal, which receives some of its water from the Provo Reservoir and the remainder from Utah Lake.

1.3.3 Geology

Regional Geologic Setting. The Jordan Valley lies along the eastern margin of the Basin and Range physiographic province and is bounded on the east by the Wasatch Mountains, the south by the Traverse Mountains, the north by the Great Salt Lake, and the west by the Oquirrh Mountains. The western side of the Jordan Valley lies in a late Tertiary structural graben, which has been down dropped along mountain range-margin faults at the edge of the Oquirrh Mountains.

Basin and Range faulting produced uplift of the mountains surrounding the Jordan Valley during the Pliocene and Pleistocene. Subsequent erosion yielded unconsolidated to semi-consolidated deposits of clay, silt, sand, gravel and boulders, which were deposited in the SWJV. These deposits occur as pedimented alluvial fans along the front of the Traverse and Oquirrh mountains. In Late Pleistocene time, inundation of the Jordan Valley by Lake Bonneville resulted in lacustrine and shoreline deposits in the central part of the valley below an elevation of 5,200 ft amsl.

Site Geologic Setting. Based on previous studies and extensive subsurface investigations, six principal geologic units have been defined in the SWJV: Paleozoic bedrock, Tertiary volcanic rock, Jordan Narrows unit, alluvial fan and basin-fill deposits, Quaternary lacustrine deposits, and alluvium and colluvium. The distribution of these units is delineated by a series of geologic cross sections that were constructed across the study area (RI report, Appendix I). Descriptions of the units are presented in the RI report (KUC 1998a).

1.3.4 Hydrogeology

Interpretation of aquifer lithology and hydrologic properties is based on water levels, water quality, borehole geophysical logging and aquifer testing. These data were used to define hydrogeologic characteristics in the aquifer, hydraulic conductivity of aquifer materials, hydraulic gradients within the aquifer, groundwater flow directions and velocities, and water quality. A brief discussion of these properties follows; refer to the RI report Appendix F for more details.

Bedrock and Jordan Narrows Unit. In the SWJV, Paleozoic bedrock and Tertiary volcanic rock both provide recharge water to the principal aquifer. The Jordan Narrows unit, first encountered at the base of the principal aquifer about one mile east of the Oquirrh Mountains, is considered an aquitard and forms the base of the principal aquifer in the central portion of the SWJV. All of these units have relatively low hydraulic conductivity compared to the principal aquifer. However, the hydraulic conductivity of the Paleozoic bedrock and Tertiary volcanic rock is highly variable depending on the presence or absence of fractures.

Most of the groundwater flow in Paleozoic bedrock is probably through secondary fracture porosity. Hydraulic conductivity estimates range from 0.01 to 1.5 ft/day, but can be greater than 100 ft/day locally. In Tertiary volcanic rocks, groundwater flow is also likely confined to secondary permeability features such as fractures and lithologic contacts. The hydraulic conductivity of the volcanic bedrock ranges from 0.03 to 0.8 ft/day. There may be local movement of groundwater through the Jordan Narrows unit, which has a hydraulic conductivity of about 0.1 ft/day to 0.3 ft/day.

Principal Aquifer. The principal aquifer consists mainly of Plio-Pleistocene alluvial fan deposits of quartzitic and volcanic gravel. Estimates of hydraulic conductivity for volcanic gravel in the western part of the SWJV range from approximately 1 to 12 ft/day, whereas hydraulic conductivity is about 3 to 83 ft/day for quartzitic gravels. Vertical conductivity estimates for the principal aquifer range from 0.01 to 12 ft/day. The variation reflects differences in clay content within the volcanic and quartzitic gravels, and the presence of clay and silt interbeds.

Shallow Unconfined Aquifer. From the former KUCC evaporation ponds to the Jordan River, the principal aquifer is confined by a low permeability zone, and consists primarily of lacustrine deposits of gravel, silt and clay, and mixtures of these materials. The hydraulic conductivity of the shallow unconfined aquifer is typically low based on lithologic logs and slug testing estimates, but is also highly variable, as shown by Lambert (1995).

Groundwater Recharge. The principal aquifer is recharged from surface infiltration of precipitation, irrigation water and canal water, bedrock inflow, and to a limited extent from surface infiltration of waters emanating from Butterfield Creek. The bedrock of the Oquirrh Mountains provides recharge to the groundwater in the western part of the SWJV, and this groundwater then travels eastward into the basin. Aquifer recharge is greater in the eastern part of SWJV from canal seepage and in the Herriman area due to recharge from surface water.

Groundwater Extraction. Most of the water extracted from the principal aquifer is used for municipal or industrial purposes. The largest extractions in the study area are from the West Jordan and Riverton city well fields and KUCC process water wells. West Jordan City extracted an average of 6,012 afy from 1990-1996 (personal communication, West Jordan City 1996) but only 3,650 afy in 1999 and 2000 (West Jordan City, 2001). Riverton City extracted about 3,300 afy (Lambert 1995), but their extraction rose to 6,100 afy in 1999 (personal communication, Riverton City, 2000). KUCC production wells (K60 and K109) extract about 5,200 afy.

Groundwater Potentiometric Surface. The depth below ground surface to the potentiometric surface of the principal aquifer in the SWJV ranges from about 40 feet in the west to over 400 feet in the center of the valley. Between the former KUCC evaporation ponds and the Jordan River, the potentiometric surface of the shallow, unconfined aquifer ranges from 10 feet to 200 feet below ground surface. Groundwater flow is predominantly west to east from the base of the Oquirrh Mountains to the Jordan

River. Groundwater in the principal aquifer near the Traverse Mountains generally flows to the northeast, changing to an easterly flow near the center of the basin.

Groundwater Elevation Changes. Groundwater elevations have declined between 2 and 3 feet per year through most of the SWJV over the past fifteen years. The greatest drop in water levels has been in the West Jordan City well field and the vicinity of the KUCC process-water wells. In these areas, the rate of decline averaged 4 to 8 feet per year between 1986 and 1996, but has slowed to about three feet per year since West Jordan City reduced pumping rates in 1996.

Water-levels along the eastern boundary of the KUCC waste rock disposal areas have fluctuated over the past decade by as much as 30 feet, depending on the location of the specific well. The observed water-level variations may be responses to changes in precipitation and recharge conditions, or they may reflect variations in leaching of the up-gradient waste rock. Leaching was discontinued in September 2000, so this variable in water-level responses now should be diminishing or even eliminated.

Water levels in the vicinity of the Large Bingham Reservoir and Lark have been stable (+/- 1 foot) over the last five years, but in the Acid Well (ECG1146) the water table is declining at about three feet per year.

The continued, overall decline of groundwater elevations in the most transmissive portions of the aquifer and the relatively rapid decline from 1991 to 1996, during the time of increased pumping from municipal well fields, indicate that more groundwater is being removed from the principal aquifer than is currently supplied by natural recharge.

Hydraulic Gradients. Horizontal hydraulic gradients in the SWJV vary considerably depending on the region. They are generally steeper near the mountains and shallower in the valley. Along a flow line from the Oquirrh Mountains to the Jordan River, the average composite horizontal hydraulic gradient is approximately 0.025.

Upward vertical hydraulic gradients are greatest near the base of the Oquirrh Mountains. Downward vertical gradients are present east of the Bingham Creek reservoir system and near the KUCC production wells. In the center of the western side of the basin (east of K60 and K109 to the former KUCC evaporation ponds), vertical hydraulic gradients are nearly non-existent. Both upward and downward gradients are found east of the former KUCC evaporation ponds, which reflects infiltration from canals and regional flow of groundwater to the Jordan River, respectively. Near the Jordan River, the vertical gradients are upward. Local variations in vertical gradients are also observed around municipal and KUCC well fields.

Groundwater Velocity. Average horizontal groundwater velocities were calculated using Darcy's Law, based on average gradients and hydraulic conductivity, and an effective porosity of 0.225, which is typical for gravel (Freeze and Cherry 1979). The overall linear groundwater velocity, based on a groundwater flow path from the Oquirrh Mountains to the Jordan River, is about 550 ft/yr (standard deviation of ± 525 ft/yr). This velocity assumes an average gradient of 0.025. In general, the average linear velocity of groundwater between the Oquirrh Mountains and Highway 111 is lower than farther east in the KUCC production well area. The lower velocity near the mountain front is due to lower hydraulic conductivity material (volcanic gravel) than in the production well area, which consists of quartzitic gravel.

Isotopic data, specifically tritium and CFCs (chlorofluorocarbons), also allow an estimate of average linear groundwater velocity to be made. In 1997, six CFC samples were collected along a flow line of the plume extending from the former Bingham Creek reservoir to the eastern edge of the plume (Solomon and Bowman 1997, Appendix K of RI report). Monitoring well P190A, located southeast of K60 just down gradient of the former Bingham Creek reservoir sulfate plume, yields a CFC-12 recharge age of 1961, which is consistent with the observed tritium activity in this well. The computed travel time from the Bingham Creek reservoir to P190A is 36 years, which yields an average linear groundwater velocity of about 500 ft/yr. Because dispersion (i.e., mechanical mixing of two fluids in the aquifer) could increase flow rates, this velocity may be in error by about 30 percent, suggesting a range in average groundwater velocity from 500 to 650 ft/yr.

1.4 Nature And Extent Of Contamination

Previous investigations and the RI report (KUC 1998a) have identified the following principal areas of mining-affected groundwater contamination: 1) down gradient and east of the Bingham reservoir system; 2) east of the former KUCC evaporation ponds; 3) Lark area; and 4) near the KUCC Eastside leach collection and containment system. Other, non-KUCC related mining related contamination also was identified in the area (e.g., ARCO Tailings). The nature and extent of contamination within each of the four principal areas of contamination are summarized below.

Bingham Creek Reservoir Area. Near the old Bingham Creek reservoir, the Bingham Creek groundwater plume is acidic and contains elevated concentrations of sulfate (averaging about 18,000 mg/L). Several metals occur at relatively high concentrations (and over a wide range of concentrations) within the Bingham Creek plume, including aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, nickel, selenium and zinc. Of these, aluminum (950 mg/L), copper (41 mg/L), iron (100 mg/L), manganese (350 mg/L), nickel (14 mg/L) and zinc (67 mg/L) are present at relatively high average concentrations, whereas arsenic, barium, cadmium, lead and selenium generally occur at average concentrations below 1 mg/L. Of these metals, only average concentrations of cadmium, copper, lead and zinc exceed their respective primary drinking water Maximum Contaminant Levels (MCLs) or action levels.

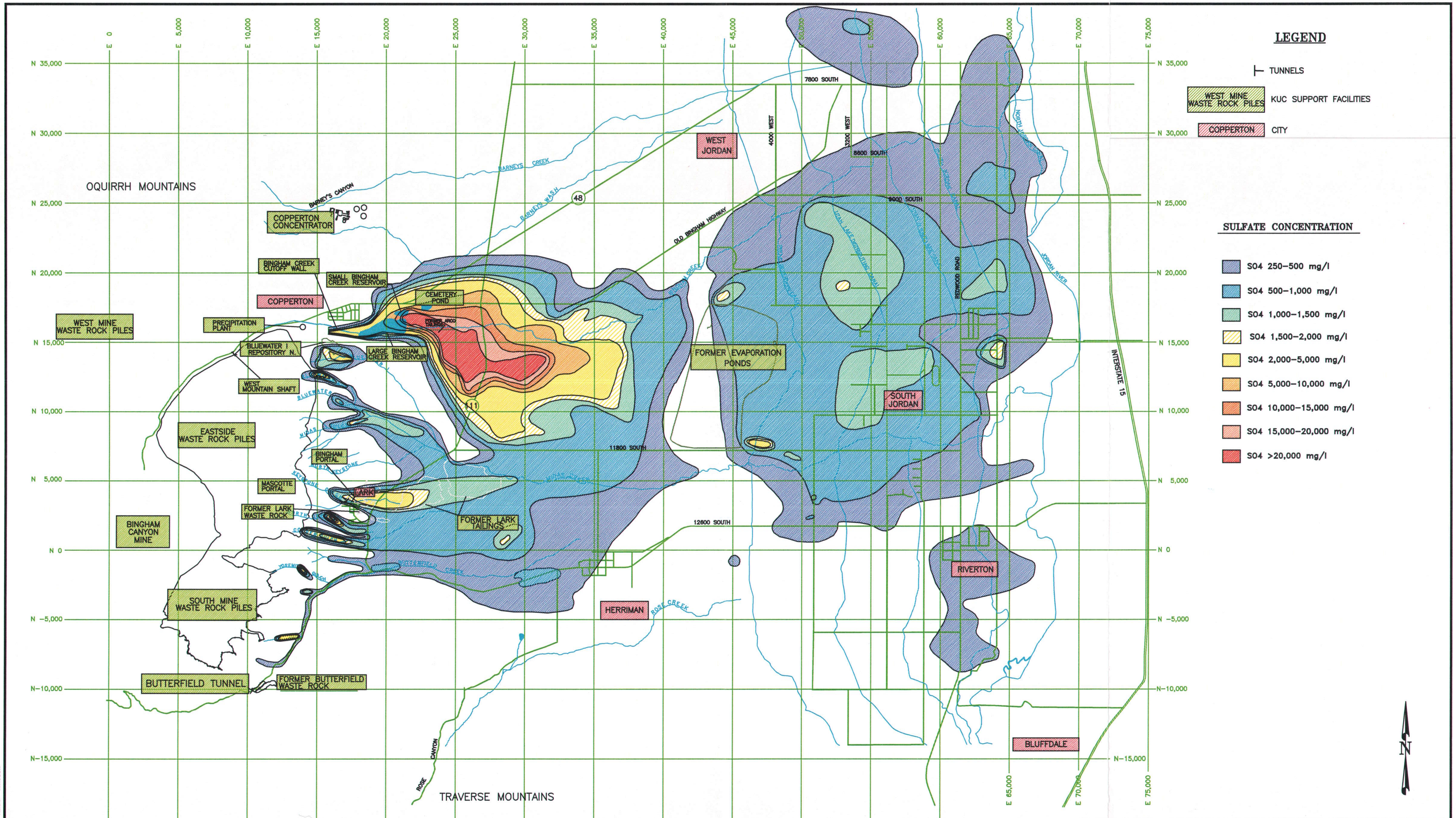
Sulfate is the most widespread contaminant related to mining activities in the SWJV. As shown in groundwater quality maps in the RI and FS (Figure 1-2), the sulfate plume associated with the Bingham Creek reservoirs is readily apparent east of the reservoirs as an elongate-shaped zone oriented in a southeasterly to easterly direction. The leading edge of this plume (as defined by sulfate greater than 20,000 mg/L) has migrated approximately 10,200 ft since the reservoirs were placed in operation in 1965. The aerial extent of the Bingham Creek plume, as defined by the 1,500-mg/L-sulfate contour is about 16,000 feet long and its widest point is approximately 11,900 ft. The total area of the 1,500 mg/L contour covers about 2,950 acres (4.6 square miles) and is generally within KUCC property boundaries.

The concentration of sulfate in the Bingham Creek plume area varies vertically as well as horizontally. The volume of elevated sulfate groundwater is greatest in the first 150 feet of the aquifer, although the volume of highly elevated sulfate (i.e., greater than 20,000 mg/L) is larger in the zone from 150 to 300 feet below the water table.

The sulfate plume thins and narrows eastward. The greatest vertical extent of sulfate occurs beneath the heart of the plume, where sulfate at concentrations greater than 20,000 mg/L is present at the base of the principal aquifer, more than 650 ft below the water table. The average thickness of the sulfate plume is approximately 300 to 350 ft. Most contaminant plumes with a source at the surface generally tend to be relatively shallow, narrow and extended in the direction of groundwater flow, particularly where horizontal hydraulic gradients are high (Freeze and Cherry 1979). The Bingham Creek plume has spread more than 650 feet below the water table in an area where some of the highest horizontal gradients are present.

The distribution of acidic groundwater (pH of less than 4.5) in the Bingham Creek plume is generally similar to that of sulfate at concentrations greater than 15,000 to 20,000 mg/L. Outside of the Bingham Creek plume (and isolated areas along the Eastside collection system), groundwater is generally neutral, with pH ranging from greater than 6.5 to near 8.0, and sulfate concentrations below 1,500 mg/L. The most acidic water (pH less than 3.5) has migrated about 10,000 ft since 1965. Within the heart of the plume, groundwater with pH of less than 4.5 also has penetrated to a depth of more than 650 feet below the water table.

N:\451\451T5101 04/04/01 12:36 kmcook



ENVIRONMENTAL ENGINEERING SERVICES		KENNECOTT UTAH COPPER
SCALE: 1" = 6500'	DATE	FIGURE 1-2
DESIGNED BY TB	3/14/97	SOUTHWEST JORDAN VALLEY
DRAWN BY CDC	3/14/97	HIGHEST SULFATE CONCENTRATION
CHECKED BY JKL	3/24/97	AT ANY DEPTH 1994-1997
PROJECT ENGINEER CS	3/24/97	
PROJECT MANAGER JFC		Job No. --- Dwg. No. 451-T5101 REV. 3

Former KUCC (South Jordan) Evaporation Ponds Area. In mining-affected groundwater east of the evaporation ponds, elevated concentrations of sulfate, magnesium and TDS are indicators of mining-related contamination. There are currently no elevated metal concentrations associated with mining-affected groundwater in this area. The average concentrations of metals with primary drinking water MCLs are all below their respective standards in groundwater east of the evaporation ponds. The metals that are present in the groundwater in this area are most likely the result of recharge of surface irrigation water and leakage from the four canals that traverse the area (SMI 1996).

Compared to the Bingham Creek plume, sulfate and other constituents occur at much lower concentrations in the area of the former evaporation ponds. Most of the groundwater east of the former KUCC evaporation ponds contains sulfate at less than 1,500 mg/L, with only isolated areas exhibiting concentrations greater than this value. The average concentration of sulfate east of the former KUCC evaporation ponds is 683 mg/L; TDS is 1,748 mg/L.

The pH distribution in this part of the SWJV is essentially neutral, indicating that any acidic water that may have recharged the aquifer has been neutralized, most likely through reactions with carbonate minerals in the aquifer matrix. Isolated areas of pH less than 6.5 are probably due to the natural variation in pH resulting from natural processes in groundwater systems (SMI 1996).

Lark Area. Water flowing from underground workings and seepage of waste rock leachate has produced an area of contaminated groundwater in the Lark area (i.e., east of the old town of Lark and near and down gradient of the Lark tailings area). Groundwater contamination in this area is shallow and less concentrated than groundwater in the Bingham Creek plume. Sulfate concentrations in mining-affected groundwater average 920 mg/L and TDS averages 2,000 mg/L.

Groundwater in the Lark area is essentially neutral, with only isolated areas containing groundwater with pH less than 6.5. Metal concentrations are low; only cadmium has been measured in mining-affected groundwater at an average concentration slightly greater than its MCL.

Most of the sulfate- and TDS-contaminated groundwater in the Lark area occurs within the upper 300 feet of the aquifer, as do the local zones of depressed pH. Beneath this zone of contamination, the quality of the groundwater is good (constituents occur at background concentrations). KUCC installed a well (LTG1139) in the deeper aquifer to demonstrate the production of high quality water.

KUCC Eastside Collection System Area. The Bingham Canyon Mine waste rock disposal areas have been actively leached for copper since 1913. In the past, some leachate generated by these activities escaped the KUCC capture system, resulting in contamination of the groundwater immediately down gradient from the waste rock. In 1996, KUCC significantly upgraded the leachate collection and containment system along the waste rock areas. This reduced the contribution of waste rock as a source of contamination to the principal aquifer by cutting off flow along the surface and in alluvium at the toe of the waste rock dumps. Active leaching stopped in September 2000, and the collection system has shown a rapid reduction of flow volumes, returning to meteoric flow values.

The mining-affected groundwater is generally shallow here, and occurs mostly in a relatively thin veneer (0 to 70 ft saturated thickness) of volcanic gravel or quartzitic gravel alluvium above volcanic bedrock. Water quality of groundwater along the waste rock areas is variable, with sulfate concentrations ranging from 42 mg/L to 22,400 mg/L, averaging 3,900 mg/L. TDS content is similar, with concentrations ranging from 376 mg/L to 27,000 mg/L, averaging 5,900 mg/L. Relatively high concentrations of sulfate correspond with depressed values of pH. For metals with primary drinking water standards, cadmium (0.11 mg/L), copper (24 mg/L) and lead (0.017 mg/L) averaged above their respective primary MCLs or action levels.

Elevated concentrations of sulfate and TDS occur in isolated areas, typically within surface water drainages along the toe of the waste rock . The maximum sulfate concentration in the area, at well P244A, decreased from 22,400 to 4,730 mg/L from 1994 to 2000.

1.5 Description of Selected Remedy

To ensure compatibility, this section is taken verbatim from the U.S. Environmental Protection Agency's Record of Decision.

> "The selected remedy for Operable Unit 2 (Southwest Jordan River Valley Ground Water Plumes) addresses the ground water contamination for this KUCC South Zone Site. The surface contamination which originally constituted the principal threat at the site has already been addressed in other removal and remedial actions at OU1 (Bingham Creek), OU3 (Butterfield Creek), OU4 (Large Bingham Reservoir), OU5 (ARCO Tails), OU6 (Lark Tailings and Waste Rock), OU7 (South Jordan Evaporation Ponds), OU10 (Copperton Soils), and OU17 (Bastian Area).
>
> "For purposes of clarifying agency authority over the cleanup operations of this action, the agencies plan on using a joint CERCLA and State NRD approach. The cleanup strategy presented within the text of this ROD is concerned primarily with the acid plume in Zone A, under CERCLA authority. EPA maintains the right to intervene in the cleanup of the sulfate plume in Zone B, if it is not addressed sufficiently by the State NRD action. The State of Utah will maintain authority of operations, in both Zones A and B, as they are intended to fulfill the requirements of the NRD settlement.
>
> "The performance standards for the selected remedy include achieving the primary drinking water standards in the aquifer of Zone A at the KUCC property line (as of the date of the signing of this document) for all hazardous substances (i.e. metals). Active remediation (pump and treat) is required to achieve the

health-based goal of 1500 ppm for sulfate while monitored natural attenuation is used to achieve the State of Utah primary drinking water standard for sulfate at 500 ppm. The water treated and delivered for municipal use must achieve all drinking water standards of the State of Utah, as a requirement of both the CERCLA action and the Natural Resource Damage (NRD) settlement between the State of Utah and KUCC. The performance standard for treatment residuals as measured at or before the end of the tailings pipe is demonstration that the tailings/treatment residuals combination meets the characteristics of non-hazardous waste.

"The selected remedy involves treatment and containment of contaminated ground water plumes. The principal threats, which caused the groundwater contamination, have been addressed in previous actions or are contained under provisions of a Utah Ground Water Protection Permit.

"The selected remedy contains the following elements:

- Continuation of source control measures as administered through the State of Utah Ground Water Protection Program.

- Prevent human exposure to unacceptably high concentrations of hazardous substances and/or pollutants or contaminants by limiting access to the contaminated ground water. Institutional controls include purchases of land, purchases of water rights, limiting drilling of new wells and increased pumping of nearby old wells as approved (on request) and administered through the State of Utah State Engineer (Division of Water Rights).

- Prevent human exposure to unacceptably high concentrations of hazardous substances and/or pollutants or contaminants through point-of-use management which includes providing in-house treatment units to residents with impacted wells, replacement of their water by hooking the properties up to municipal drinking and/or secondary supplies, and/or modifying their wells to reach uncontaminated waters.

- Contain the acid plume in Zone A by installation of barrier wells at the leading edge of the contamination (1500 ppm sulfate or less), pump and treat the waters to provide a hydraulic barrier to further plume movement while providing treated water for municipal use. The treatment technology for the barrier well waters is reverse osmosis.

- Withdraw the heavily contaminated waters from the core of the acid plume in Zone A and treat these contaminated waters using pretreatment with nanofiltration or equivalent technology, followed by treatment with reverse osmosis to provide drinking quality water for municipal use.

- Monitor the plume to follow the progress of natural attenuation for the portions of the Zone A plume which contain sulfate in excess of the state primary drinking water standard for sulfate (500 ppm sulfate).

- Disposal of treatment concentrates in existing pipeline used to slurry tailings to a tailings impoundment prior to mine closure.

- Development of a post-mine closure plan to handle treatment residuals for use when the mine and mill are no longer operating.

"Statutory Determinations

"The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

"This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

"Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure the remedy is, or will be, protective of human health and the environment."

1.6 Preliminary Failure Modes and Effects Analysis (FMEA)

As with most CERCLA actions, the RI/FS phase did not produce all the data needed for the Remedial Design. To determine the sorts of information needs that are most critical to successful performance of the selected remedy, KUCC consulted its design team to identify gaps in support information and underlying data. In addition, KUCC elected to use a style of engineering risk assessment called "Failure Modes and Effects Analysis" (FMEA). FMEA is a qualitative evaluation that uses experienced specialists to describe an engineered system in terms of its critical components. Using this description of the system and its components, the specialists then systematically identify (a) ways in which adverse effects could arise; (b) the severity of the consequence(s) of those effects; and (c) how the project could mitigate the adverse effects.

The FMEA process allows the project team to concentrate on the information needed to control risk in the components and the overall system. It provides a traceable rationale for the identification of data needs, and therefore for the studies and projects needed to resolve the remaining uncertainties. The preliminary FMEA for this project is summarized in Table 1-1, and the results of this evaluation are used in Section 3.0

Technical Scope of Work to formulate the design investigations and design-support activities that are the principal subject of this Work Plan.

Table 1-1. Summary of Preliminary Failure Modes and Effects Analysis (RD Work Plan Section 1.6)

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Groundwater Collection and Containment System			
Well Casing Fails Above Plume	1. Acidic or high-SO4 water flows to vadose zone and re-infiltrates 2. Extraction rate compromised	1. Low: re-infiltration local to existing plume 2. Low to Moderate, depending on amount of flow lost	1. Plug and redrill well 2. Sleeve well
Extraction rate does not contain plume	Plume is not contained; water quality degrades downgradient	High to Extreme	1. Reconfigure pumping 2. Increase extraction rates 3. Install and pump additional wells 4. Add injection wells to improve containment
Extraction rate creates overdraft on aquifer	Rate of water-level decline exceeds State Engineer's guidelines	Moderate (e.g., adjust pumping rates) to severe (e.g., adverse impacts to water rights or ground subsidence)	1. Monitor water levels against predictions and adjust pumping as necessary; 2. Respond to direction from State Engineer 3. Add injection wells to improve containment
Delivery pipeline fails	1. Contaminated water spills to surface 2. Delivery rate to water treatment (NF and RO units) is compromised	1. Low and local if quickly contained. Could be moderate to high if unidentified for long period 2. Low to moderate, depending on volume and period of interruption	1. Place pipelines above ground for inspection 2. Monitor flow rates and shut down flow automatically if rate falls out of control 3. Double-wall (or otherwise contain) pipelines 4. Leak detection in double-wall, with failsafe 5. Storage during repairs or shut down pumping

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Water Treatment (NF and RO) and Hydraulic Delivery Systems			
Larger volumes than anticipated require treatment and distribution	1. Capacity must be increased 2. Rate of aquifer clean-up compromised	1. Low (technical) to moderate (cost) 2. Moderate to high, depending on scale of modification to schedule	1. Add additional treatment and/or delivery capacity 2. Add additional residential handling capacity
Quality of extracted water degrades beyond requirements of RO feed water	1. Increased feed pressure 2. Lower permeate recovery and quality	Low (technical) to moderate (cost)	1. Blend with low-TDS water 2. Use nanofiltration or other treatment
Concentrate pipeline fails	1. Contaminated water spills to surface 2. Delivery rate to Copperton tailings line compromised	1. Low and local if quickly contained. Could be moderate to high if unidentified for long period 2. Low	1. Place pipelines above ground for inspection 2. Monitor flow rates and shut down flow automatically if rate falls out of control 3. Double-wall (or otherwise contain) pipelines 4. Provide temporary storage (e.g., Desilting Basin) while pipeline is repaired
Permeate pipeline fails	1. Clean water delivery interrupted 2. Regulatory impact for drinking water supplies	Low to moderate	1. Restore flow 2. Provide alternative fresh water through purchase or alternative source

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit			
Mechanical failure of tailings pipeline	1. Contaminated water and solids spill to surface 2. Groundwater extraction and treatment rates compromised; 3. Copper production curtailed	1. Low and local if quickly contained; could be moderate to high if unidentified for long period 2. Low to high, depending on volume and period of interruption 3. Moderate to extreme, depending on length of curtailment	1. Inspect and maintain 2. Monitor flow rates and shut down flow automatically if rate falls out of control [NB: Very difficult technically] 3. Store concentrates (e.g., in Desilting Basin) until tailings flow restored
Pipelinescale affects performance	1. Scale adversely affects pipeline performance or maintenance schedule	1. Low (technical) to moderate (cost)	1. Control scale by chemical management or physical removal
Tailings circuit does not adequately control chemistry	Chemistry of decant pool exceeds discharge criteria 2. Chemistry of return flow exceeds processing criteria	2. Moderate if system recovers quickly; high if prolonged. 3. High to very high	2. Control discharge, or treat decant pool, if a short-term problem 3. Adjust chemistry of process-water, if a short-term problem 4. Blend with gray water (or other waters) 5. Long-term mitigation currently undefined
Metals and metalloids not irreversibly removed in tailings solids	Adverse water-quality impacts to discharge	Low (if reversibility is low) to very high	Long-term mitigation currently undefined

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Treatment of Water-Treatment Concentrate in KUCC Tailings Circuit (con.)			
Tailings acidified	1. Adverse water quality impacts to GW and SW discharge 2. Adverse impacts to surface reclamation 3. Regulatory & permitting impacts	Moderate (if acidity, metals fluxes are low) to extreme	1. Long-term mitigation currently undefined 2. Re-vegetate with resistant species; soil amendments to control phytotoxicity
Water quality not suitable for discharge to GSL at end of mining	Alternative for water and chemical management required	Moderate (if flow volumes and chemistry are moderate) to extreme	1. Evaporation with "RCRA" containment for solids 2. "Land application", if concentrations do not exceed regulatory limits

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall organization of the project team for the remedial design phase and its relationship to EPA and UDEQ oversight is shown in Figure 2-1. The specific responsibilities of each individual or group are discussed below.

2.1 KUCC Personnel

Mr. Jon Cherry, P.E., will be the KUCC Project Manager and main point of contact for communications to and from KUCC. Mr. Cherry is designated as the Design Professional for this program. Mr. Cherry will be responsible for day-to-day communication with the EPA and UDEQ oversight as well as with contractors and consultants hired for specific tasks. His general responsibilities include implementation of a remedial design that will meet the performance criteria specified December 13, 2000 Record of Decision (ROD). As project manager, Mr. Cherry will define and clarify the scope of work and objectives for each major activity, and then he ensure the technical, budget, permitting and schedule requirements are met. Mr. Cherry is a registered professional engineer with over ten years of RCRA, CERCLA, SARA, and environmental permitting and compliance experience.

Mr. Bart Van Dyken is the KUCC Director of Engineering Services and will oversee the design, construction and operation of the extraction and treatment facilities. He will be responsible for coordinating the necessary resources to accomplish the design of the various elements and to complete the remedial design phase on schedule. Mr. Van Dyken and his staff will be responsible for the design, documentation, procurement, accounting and construction management of the containment/extraction wells, delivery of the extracted water to the Nano-Filtration (NF) and Reverse Osmosis (RO) treatment plants and delivery of the treated waters and concentrate streams to water suppliers and the tailings line, respectively. Mr. Van Dyken has over 25 years of engineering experience in large-scale production and environmental remediation projects.

2.2 Consultants/Contractors

Mr. Helmar Bayer is the president of HBC International, Inc. and has contracted to KUCC for the past 10 for treatability testing and design of the nanofiltration and reverse osmosis treatment plants. Mr. Bayer will continue in this capacity, working directly with KUCC Engineering Services, to design, construct and operate the treatment facilities. Mr. Bayer holds a M.S. in food and fermentation technology and has over ten years experience in wastewater treatment design.

Mark Logsdon is principal geochemist and president of Geochimica, Inc. and has contracted to KUCC to perform specific geochemical investigations related to the remedial design as well as provide other technical oversight throughout the remedial design process. Mr. Logsdon holds a M.S. in geology with specialization in geochemistry, has published numerous articles on specific geochemical issues and is a recognized expert in his field, with more than 25 years experience in mining-related geochemical studies.

Brian Vinton is president of North American Mine Services (NAMS). Mr. Vinton and his staff of engineers and technicians have contracted to KUCC over the past ten years for source removal/control projects and RIFS. Mr. Vinton holds a B.S. in earth science and has over 20 years of experience in the exploration, mining and environmental remediation fields. NAMS is contracted to KUCC as part of the remedial design project to provide technical review, GIS support, groundwater modeling, groundwater data management and source control evaluation.

2.3 Government Oversight: EPA/UDEQ

Dr. Eva Hoffman is the Remedial Project Manager (RPM) from EPA Region VIII for the remedial design. Dr. Hoffman has been the EPA lead project manager for this project during the source removal/control projects and RIFS and will be responsible for coordination of all oversight for the project from EPA's perspective. She also will be responsible for contracting technical support and review from the U.S. Army Corps of Engineers and United State Geological Survey (USGS) to support her oversight role. Dr. Hoffman's responsibilities include ensuring that the remedial design will meet the performance criteria established in the ROD, that the public's interests are protected and that all federal administrative requirements are met.

Mr. Doug Bacon will be the lead project manager from the State of Utah Department of Environmental Quality (UDEQ) for the remedial design phase of this project. Mr. Bacon was the lead project manager for UDEQ during the FS and ROD. Mr. Bacon will be responsible for coordination of all oversight for the project from UDEQ's perspective and ensuring that all State administrative requirements are met.

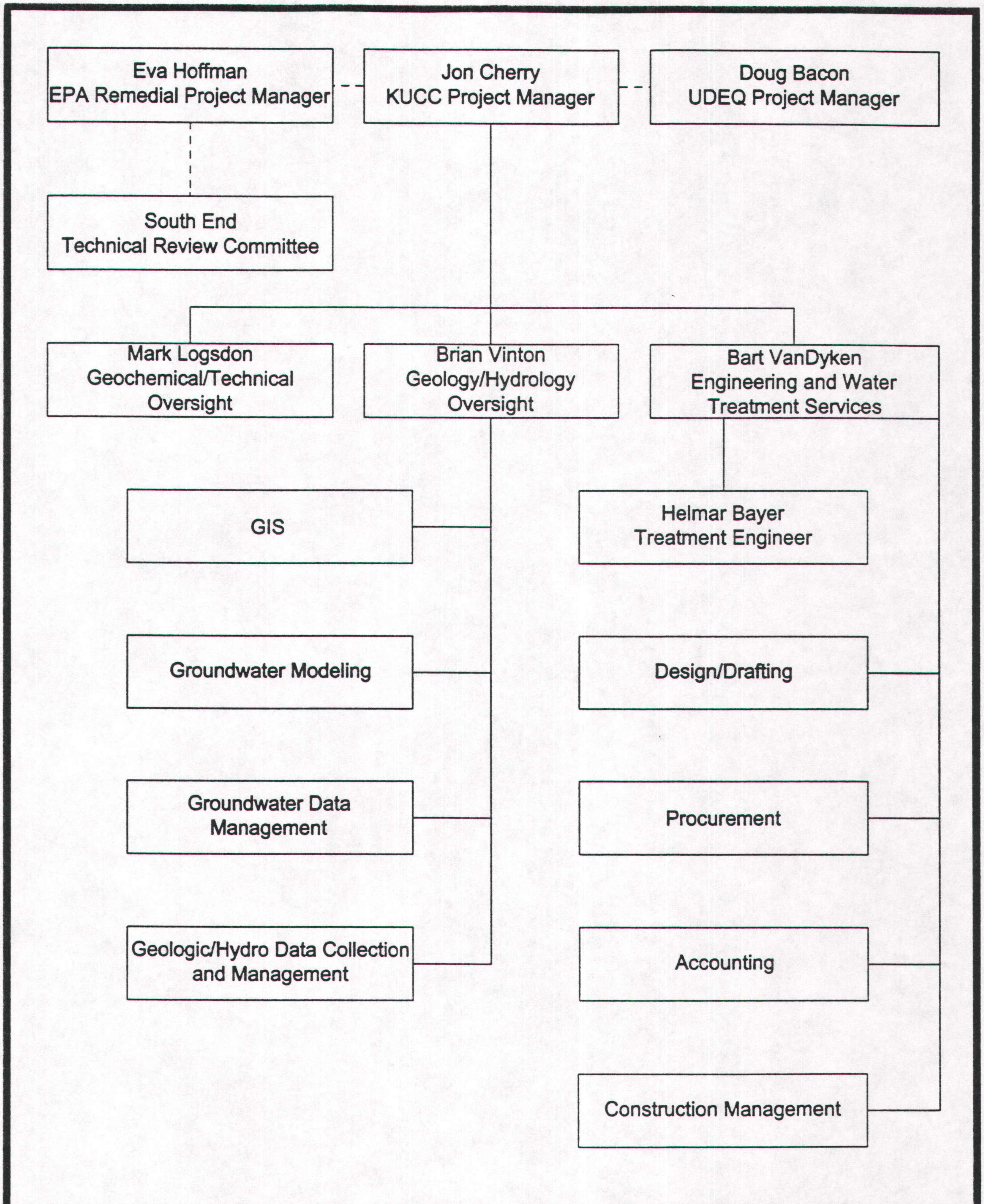
2.4 Technical Review Committee (TRC)

The TRC was formed during the initial stages of the RI and has continued through the FS and into the remedial design. The committee is comprised of representatives from Kennecott, various federal, state and local government agencies, as well as, representatives from local municipalities and local residents. The TRC is co-chaired by the KUCC, EPA and UDEQ project managers. There are two purposes of the TRC. First the TRC provides a forum in which the technical details and progress of the remedial design can be communicated in a transparent process that allows open dialog between the interested parties. The second purpose of the TRC is to provide technical review in their respective areas of expertise to ensure that basic assumptions are credible and critical details are not overlooked. Table 2-1 is current listing of TRC members, their affiliation, phone number and email address.

Table 2-1 SOUTH FACILITIES TECHNICAL REVIEW COMMITTEE

	NAME	AFFILIATION	PHONE NUMBER	*EMAIL*
1	Eva Hoffman	EPA	303-312-6764	Hoffman.eva@epamail.epa.gov
2	Helen Dawson	EPA	303-312-7841	Dawson.helen@epamail.epa.gov
3	Brent Everett	UDEQ – DERR	801-536-4171	Beverett@deq.state.ut.us
4	Doug Bacon	UDEQ – DERR	801-536-4282	Dbacon@deq.state.ut.us
5	Dennis Frederick	UDEQ – DWQ	801-538-6038	Dfrederick@deq.state.ut.us
6	Dan Hall	UDEQ – DWQ	801-538-9153	Dhall@deq.state.ut.us
7	Bill Moellmer	UDEQ – DWQ	801-538-6329	Wmoellme@deq.state.ut.us
8	Frank Roberts	UDEQ – DDW	801-536-0098	Droberts@deq.state.ut.us
9	Doug Taylor	UDEQ – DSHW	801-538-6857	Dtaylor@deq.state.ut.us
10	Chuck Williamson	UDNR – Water Rights	801-538-7392	Nrwrt.cwilliam@state.ut.us
11	Jared Manning	UDNR – Water Rights	801-538-7455	Nrwrt.jmanning@state.ut.us
12	Tom Munson	UDNR – DOGM	801-538-5321	Nrogm.tmunson@state.ut.us
13	Brenda Landureth	UDNR – GSL	801 538-5273	Nradm.blandure@state.ut.us
14	Bert Stolp	USGS	801-908-5061	Bjstolp@usgs.gov
15	Tom Munson	DOGM	801-538-5321	Nrogm.tmunson@state.ut.us
16	Richard Bay	JVWCD	801-565-8903	RichardB@jvwcd.org
17	Mark Atencio	JVWCD	801-565-8903	MarkA@jvwcd.org
18	Richard Dansie	HRRR	801-254-4377	
19	Michelle Baguley	HRRR	801-254-4921	Mbaglady@hotmail.com
20	Roger Payne	West Jordan City	801-569-5761	RogerP@Wjordan.com
21	Steve Noble	South Jordan City	801-253-5230	Snobel@Sjordan.state.ut.us
22	Scott Endicott	Sierra Club	801-596-1325	Scott.endicott@cores.utah.edu
23	Mary Pat Buckman	SLCo. Health Dept.	801-313-6707	Mbuckman@eh.co.slc.ut.us
24	Ivan Weber	KUDC	801-743-4617	Kiweber@Kennecott.com
25	Ryan Evans	KUCC	801-569-6961	Krevans@Kennecott.com
26	Brian Vinton	KUCC-NAMS	801-569-7887	Kbvinton@Kennecott.com
27	Jon Callender	KUDC	801-743-4618	Kjcallen@Kennecott.com
28	Jon Cherry	KUCC	801-252-3126	Cherryj@Kennecott.com
29	Mark Logsdon	KUCC-Geochimica	805-640-8697	Mark.Logsdon@worldnet.att.net
30	Helmar Bayer	KUCC – HBC International	801-569-7301	Khbayer@Kennecott.com

(REVISED March 30, 2001)



LEGEND	FIGURE 2-1	KUCC SOUTH FACILITIES RD
- - - - - - communication	Prepared by: JCC	
———— authority	Date: 3/16/01	PROJECT ORGANIZATION

3.0 TECHNICAL SCOPE OF WORK

3.1 Design

3.1.1 Purpose, Scope and Objectives of the Design

The purpose of the Remedial Design (RD) is to develop and document the technical requirements of the Remedial Action that will be executed by KUCC to resolve the CERCLA issues associated with contamination of groundwater from mining activities associated with the South Facilities of the Bingham Canyon mining complex. The general nature of the selected remedy and an overview of the conceptual design for that remedy have been presented in Sections 1.4 and 1.5, above.

The scope of the RD includes engineering plans for three "functional units" of the conceptual plan:

- Groundwater containment and extraction system;
- Water treatment (NF and RO) and hydraulic delivery system for treated water and concentrate
- Treatment of acid-plume (NF) and Zone A (RO) concentrates and meteoric-leach water in KUCC tailings circuit.

The RD will address processes and designs that will be used by KUCC to meet the terms of the ROD both during operational stages and after the end of mining. It is expected that the level of detail for the operational phase will be greater than for the end-of-mining phase, as we expect that much will be learned during the period of expected operation that cannot be anticipated in detail at this time.

It is expected that the product of the RD process will be plans and specifications for a performance-based Remedial Action that would be detailed and executed by KUCC or the selected contractor(s). Objectives of the RD include:

- Identify data needs that must be resolved to develop the design criteria for each functional unit
- Develop and execute supplemental testing, sampling and analytical programs to address the data needs; these may include field and treatability studies
- Identify design criteria for each "functional unit" of the conceptual design; it is expected that the design will be primarily performance-based.
- Document the performance-based designs in detailed plans and specifications.

3.1.2 Design Criteria and Data Needs

This section will be organized around the three "functional units" identified above. The data needs are derived from the preliminary Failure Modes and Effects Analysis (FMEA) documented in Table 1-1 of Section 1.6 above.

3.1.2.1 Groundwater Containment and Extraction System

The selected remedy begins with a groundwater containment and extraction system that will (a) control further migration of mining-affected water, (b) remove mass of contaminants from the groundwater system, and (c) deliver the contaminated water to a water-treatment system, either the NF unit for acidic plume waters or one of the RO units for high-sulfate, non-acidic groundwater from Zone A.

The RD will document final design criteria for groundwater extraction from Zone A, including the acidic plume water, and delivery of those waters from the wellheads to the water treatment system for the South Facilities. The criteria will address locations, well and pipeline designs, and design-basis extraction rates for specific wells. The current, conceptual extraction plan for Zone A is summarized in Table 3-1.

Table 3-1
Annual Groundwater Extraction Volumes – Zone A

Wells	*Extraction Rate (gpm)*	*Annual Extraction (acre-feet)*
Zone A Acid Well	1500 – 2500	2400 – 4000
Zone A (Wells 1193/1201)	2000 – 2200	3500
Zone A Sulfate Well (Well 1147)	500	800
TOTAL	*4,500 – 5,500 gpm*	*7,200 - 8,800 AF*

In addition to groundwater extraction wells, the RD will document design criteria for conveyance pipelines that deliver extracted groundwater from the wells to the water-treatment system.

The RD will evaluate the groundwater extraction systems in the context of the full groundwater hydrology of the site, including the Eastside Collection System and the mine de-watering program. However, the design will include criteria for only those extraction and collection systems that are part of the CERCLA remedy. In addition to engineering designs for the extraction and collection systems, the RD will establish performance criteria and a monitoring system to demonstrate that the systems are working as designed.

The initial failure modes and effects analysis has identified only three issues with significant consequences for the groundwater extraction and delivery system:

a) Greater than currently planned volumes (including additional volumes collected from larger areas) of groundwater need extraction to control the plume(s) or to provide sufficient clean water to meet NRD commitments

b) Pumping rates over-draft the aquifer and extraction must be decreased

c) A pipeline failure between wellhead(s) and water treatment facilities spills contaminated groundwater.

To address optimization of the extraction system, additional data and analyses may be needed to optimize: (a) well placement and the pumping-system configurations; (b) local and total extraction rates; and (c) material properties of the wells, based on the chemical reactivity of water in the proposed pumping locations. There also may be a need to further refine the hydraulic analysis to consider the cost-effectiveness of combining hydraulic injection of clean water with groundwater removal at nearby wells in terms of optimizing the containment and treatment goals of the project.

Pipeline failures are addressed through the mine's general spill prevention, control and containment plans (SPCC), which will be updated as necessary to address the specific pipelines of this project. No additional studies are expected.

3.1.2.2 Water Treatment (NF and RO) and Hydraulic Delivery System for Treated Water and Concentrate

KUCC already has developed preliminary designs for water-treatment processes and has demonstrated the technical feasibility and cost-effectiveness of the unit processes at both pilot- and initial (ca. 30% of final production rate) operational scales. The water treatment processes include nanofiltration (NF) for waters from the acidic plume and reverse osmosis (RO) for other Zone A waters that are high in sulfate but are not highly acidic. A separate RO unit will be used to treat the permeate (i.e., clean water) from the NF unit prior to discharge. Performance criteria for the unit processes have been defined. In addition, KUCC already has a storage and pipeline system for delivery of poor-quality water from the South Facilities to the KUCC tailings circuit.

With respect to normal operations, the remaining Design tasks for this functional unit are:

(a) Optimize the water-treatment system across the remaining scale-up levels;

(b) Document the final designs for the storage and pipeline facilities for the water-treatment system;

(c) Document plans and specifications for the pipeline system(s) that will deliver clean water, and

(d) Document a monitoring program to demonstrate that the system and its components are operating in control with respect to its performance criteria.

The only failure mode with significant consequences for the treatment system that has been identified to date is the possibility that larger volumes of groundwater requiring treatment would be extracted than is currently planned. The Final Design will include a description of plans and schedules to expand the capacity of the treatment systems, should unexpected, additional capacity be required in the future.

3.1.2.3 Management of Water Treatment Concentrates (NF and RO) in KUCC Tailings Circuit

While the mine is operating, concentrates from the acid-plume (NF) and Zone A RO treatment systems will be conveyed to the Magna Tailings Impoundment (North Impoundment) in two existing pipelines. After mine closure, effluents from the treatment systems will be conveyed to the Great Salt Lake via a concentrate discharge line, provided the water chemistry at that time meets discharge limits. If one or both of the concentrates is not suitable for direct discharge, then additional treatment (e.g., lime addition) or alternative disposal (e.g., evaporation) will be needed. If concentrate from treatment of Zone B wells cannot be discharged to the Jordan River, these concentrates may also be delivered to the KUCC system.

The RD will document the plans and specifications for pipelines from the treatment facilities to the disposal points, including plans to control and remove (as necessary) scale in the discharge lines. No additional technical studies are anticipated for this activity. Spill containment and contingency plans will be documented under modifications to existing KUCC plans.

An innovative aspect of the disposal system is the use of the KUCC tailings circuit to neutralize acidity and remove metals and metalloids from water-treatment concentrates and meteoric leach waters. Preliminary, bench-scale testing and ongoing, water-quality monitoring programs and mass-balance modeling (addressing inclusion of groundwater plume and leach-circuit water in the tailings slurry) have shown that treatment is feasible at flow rates up to approximately 67percent of the expected full-scale rates. The concentrator and tailings-disposal system have the capability of adding additional lime to the system to control pH, if necessary. Final performance standards for this portion of the remedy need to be developed and documented as part of the RD.

Preliminary analysis has identified three potential failure modes with significant consequences for the remedial action regarding treatment of NF and RO concentrates in the tailings circuit:

a) Mechanical failures of the slurry pipeline system

b) Treatment of the full-scale system in the tailings circuit does not reduce adequately the acidity and metals concentrations in the slurry under short- or long-term conditions

c) Water quality of residual effluents is not adequate for direct discharge to Great Salt Lake when mining ceases.

KUCC's SPCC procedures will be updated, as necessary, as part of the Final Design to address the slurry pipeline during Remedial Action. The potential for scale to develop in the pipeline at volumes sufficient to affect the performance of the treatment and delivery system has been recognized by KUCC, and procedures to control or remove scale have been developed. The monitoring and maintenance programs addressing scale will be addressed in the Final Design.

To date, laboratory test work, monitoring and modeling have not addressed the specific mechanisms of metals removal in the tailings circuit, impacts (if any) of short-term excursions in slurry and decant chemistry on metals in the tailings system, the long-term geochemical stability of the metals from this waste stream in the tailings environment, or the full-scale addition of the groundwater treatment streams to the tailings circuit. Therefore, additional studies (Section 3.1.3.3 and Attachment 1, below) will be undertaken during the RD process to answer these data needs and to determine the detailed plans and specifications needed to achieve the performance standards for this functional unit of the remedy. The additional studies also will address (a) treatment alternatives for the period in which mining is completed and tailings no longer are available, and (b) monitoring programs to demonstrate that the operational system will meet the performance standards.

There are two conceptual routes by which water-quality of the water-treatment effluents may not be satisfactory for discharge to GSL:

a) Mining continues as anticipated in the RI/FS, however the extraction system does not achieve the requisite restoration of groundwater quality by the time mining ceases.
b) There is a premature closure of mining operations or a curtailment of mining that reduces the tailings production to levels that do not provide adequate treatment.
c) The existing system fails to treat effluents to acceptable levels.

The former case can be addressed, in part, by careful monitoring of water quantity in the aquifer during the extraction process. When the monitoring data are assessed through ongoing groundwater flow and transport modeling, KUCC could modify extraction rates to accelerate removal and treatment. A comprehensive performance monitoring program will be part of the Final Design.

If operational adjustments to the design-basis system are inadequate, then the problem becomes equivalent to the second variant of this failure mode. As discussed conceptually in the Feasibility Study and ROD, discharge to GSL will occur if and only if the effluent quality meets discharge standards that will be developed under a UPDES permit for such disposal. Therefore, as part of the RD, KUCC will review, update and expand, as necessary, the alternative disposal options that were identified in the FS. These may include, but not necessarily be limited to, evaporative disposal in engineered cells in the final tailings surface or on the waste-rock piles; chemical (e.g., lime) treatment with subsequent water management and solids handling; and advanced water-treatment systems to remove acidity.

These contingencies are considered unlikely in the short term, and they are very unlikely to be required rapidly or without warning. The underlying situations would develop over a substantial period of time and could be identified through the base-case monitoring programs and KUCC's mine-planning process. This would allow KUCC ample time to consult with EPA and UDEQ to take proactive measures. Therefore, the additional activities addressing these matters in the RD are expected to develop information only to the level of a Preliminary Design.

3.1.3 Design Tasks/Activities

The RD tasks and activities are identified by functional unit, as discussed above. Tasks or activities that are annotated with the symbol (**) are ones for which a report of investigations is anticipated. The results of the other tasks and activities will be incorporated into the Preliminary and/or Final Design Reports.

3.1.3.1 Groundwater Containment and Extraction System

Tasks and activities related to the groundwater containment and extraction system include:

a) Complete the necessary Preliminary Evaluation Reports (PERs) and Drinking Water Source Protection (DWSP) plans for each existing and new well (**)
b) Document performance criteria for extraction wells (e.g., volume of water extracted; water-level response; water-quality changes), and prepare annual performance charts documenting well performance and KUCC response to issues (**)
c) Document baseline water-level and sulfate condition for Zone A and adjacent areas at initiation of RD process (**)
d) Update and recalibrate the groundwater flow and transport models (**)
e) Optimize well-field geometry and pumping rates (**); it is expected that the optimization studies would address alternative pumping strategies if physical or chemical responses in the aquifer are unsatisfactory
f) Evaluate clean-water injection to supplement containment (**). If injection is recommended, separate activities will be initiated promptly to address permitting and injection-specific monitoring
g) Document monitoring programs [including methods and procedures (e.g., specific analytes and sampling frequencies in specific wells) for monitoring and for quality control] that will be used to operate the flow system and to demonstrate compliance with the performance standards for the containment and extraction system. (**)
h) Document quantity and quality of all groundwater flows that will be routed to the treatment system (**)
i) Develop contingency plans for mitigation of water level declines, if these exceed performance criteria for the Principal Aquifer during the Remedial Action (**)
j) Document schedule for well and pipeline construction
k) Document construction, development and procedures for wells and pumps;
l) Document pipeline plans and specifications
m) Document operations and maintenance plans for wells, pumps, pipelines and monitoring systems
n) Update existing spill containment and contingency plans for inclusion in the Final Design Report.

3.1.3.2 Water-Treatment and Hydraulic-Delivery System for Treated Water and Concentrate from both NF and RO Units

Tasks and activities related to the water-treatment and hydraulic-delivery systems include:
a) Document as-built plans for treatment system, including non-proprietary data and generalized flow sheets for processes

b) Document design-basis treatment capacity requirements as a function of time (**)
c) Optimize unit processes as flows increase and empirical water quality develops
d) Document schedule to increase capacity of modular treatment streams
e) Document pipeline plans and specifications
f) Document monitoring program to demonstrate that permeate for delivery to drinking-water suppliers meets all performance standards (**);
g) Document monitoring plan for treatment of concentrate (**)
h) Document operations and maintenance plans for treatment and monitoring systems
i) Update existing spill containment and contingency plans for inclusion in the Final Design Report.
j) Obtain construction permit for Zone A RO treatment plant.

3.1.3.3 Management of Meteoric Leach Water and Water-Treatment Concentrates in KUCC Tailings Circuit

Tasks and activities related to management of meteoric leach water and water-treatment concentrates in the KUCC Tailings Circuit include:
a) Document the existing mass-balance model for the tailings circuit and evaluate the need for and feasibility of adding additional reactive chemistry to the model (**);
b) Evaluate changes in slurry chemistry through tailings circuit as a function of (i) mine planning, (ii) ore feed and tailings management, and (iii) Zone A concentrate inputs (**)
c) Evaluate specific removal mechanisms that occur in different parts of the tailings circuit (**)
d) Evaluate the time-variant stability of attenuated metals and metalloids in the tailings impoundment (**)

A more detailed scope of work for this component is provided as Attachment A.

In addition, the geochemical work plan will evaluate alternative treatments (e.g., lime treatment and evaporation) to address the period when tailings are not available for reaction. These studies also will include reports of investigations.

3.1.4 Design Deliverables

KUCC anticipates four, principal deliverables as part of the Remedial Design Phase:
1. Remedial Design Work Plan
2. Preliminary Design Report
3. Reports of investigations for the additional field and treatability studies identified above
4. Final Design Report.

As discussed in Section 2.4 above, KUCC will utilize the Technical Review Committee to provide peer review of the RD process and products. KUCC anticipates regular, quarterly meetings with EPA's Technical Review Committee, as well as other, topical meetings with the TRC that may be suggested by either KUCC or the TRC. TRC meetings will be documented through written minutes. There will be monthly progress reviews with EPA (Section 2.3, above), and topical or programmatic reviews could be initiated by EPA's RPM at any time.

3.2 Failure Modes and Effects Analysis

The Failure Modes and Effects Analysis will be reviewed and updated, as necessary, as part of both the Preliminary Design and the Final Design.

3.3 Health and Safety Plans

Typical CERCLA remediation sites have their own Site Specific Health and Safety Plan (HSP). Unlike most typical CERCLA remediation sites, KUCC is an active industrial mining site that is administered under the Mine Safety and Health Administration (MSHA) under regulations encoded in 30 CFR 56 (Safety and Health Standards Surface Metal and Nonmetal Mines). This agency certifies KUCC's safety program and conducts random safety audits throughout the year. All KUCC employees and contractors working on site are required to complete the mandatory MSHA safety training before they are allowed to work on site. Strict compliance with KUCC's safety program is mandatory as detailed in KUCC's safety standards manual. In addition to receiving the MSHA training, contractors also participate in a pre-job conference to review in detail the specifics of the upcoming work to be performed, all applicable safety requirements and any environmental requirements that they are expected to meet.

KUCC's existing, MSHA certified, safety program has been effectively used during the source removal/source control and RIFS projects in lieu of a project specific HSP. This same approach will be continued during the remedial design.

3.4 Data and Records Management Plan

As part of the remedial design, a Data and Records Management Plan (DRMP) will be prepared to document the data and records management process. The DRMP will present the strategy for documenting, managing and storing information and reports generated as part of the remedial design and remedial action phase. The DRMP will address handling of electronic files as well as hard copies. The record keeping and retention procedures will be consistent with KUCC's agreements with agencies. The DMRP also will discuss the procedures for transferring data (both hard copies and electronic) to EPA and UDEQ.

3.5 Monitoring Plan for Remedial Action

Typically, a Sampling and Analysis Plan (SAP) is prepared for all project related sampling. The SAP consists of three parts; 1) Field Sampling Plan (FSP), 2) Quality Assurance Project Plan and 3) Data Management Plan. KUCC is in a unique situation in that it has an existing and ongoing Ground Water Characterization and Monitoring Program (GCMP). The GCMP documents all the Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP), data management and sampling locations and frequencies for all surface water and groundwater samples collected at KUCC as part of State surface water and groundwater discharge permits. The GCMP is a

State approved plan and has been used as the accepted QAPP and Data Management Plan during the RIFS projects.

For the remedial design and remedial action, the GCMP will continue to be used as the QAPP. The data management for the remedial design and remedial action will be implemented as described in section 3.5. A new Monitoring Plan will be developed specifically to document and evaluate; 1) baseline water levels and the effects of long term pumping, 2) changes in water quality as a function of pumping and 3) the effectiveness of containment and extraction strategies described in the ROD. The Monitoring Plan will describe the sampling objectives, sampling program and schedule, sample handling and analysis, data quality objectives and analytical laboratories to be used. The Monitoring Plan also will describe the means of reporting the results of the sampling activities.

4.0 PERMIT REQUIREMENTS PLAN / INSTITUTIONAL CONTROL PLANS

4.1 Permit Requirements Plan

The following draft Permits Requirements Plan was prepared to identify the applicable or relevant and appropriate (ARARs) pertaining to permits for the work to be completed as part of implementing the remedy at the site. The plan also presents how the substantive requirements of these permits will be met, at least to the extent that it is known at this early stage of the remedial design process. As the design progress, the specific permit requirement will be identified and addressed in more detail. A final Permitting Plan will then be generated as part of the Preliminary Design Plan.

Typically when remedial activities are being conducted pursuant to a Consent Decree or AOC which state that the actions are consistent with the National Contingency Plan and CERCLA, permits are not required for any onsite work. Because of the unique nature of this project, permits will be obtained where necessary and appropriate (i.e., part of the remedial design will create a clean drinking water source for municipal consumption). Permits that are typically required for the activities associated with the selected remedy are outlined below.

4.1.1 Effluent Discharge Permit

As outline in the ROD, remedial activities to be conducted at the site will generate the following waters which will be discharged to KUCC's tailings circuit: 1) NF Plant concentrate and 2) RO Plant concentrate. Excess water from the tailings circuit is discharged to the GSL through a UPDES permitted outfall (012). The conditions of discharging the concentrate streams to the tailings circuit are that the tailings slurry is not characteristically hazardous when it leaves the pipeline and that the existing UPDES permit conditions are met at the outfall. The existing permit also indicates that if the quantity or quality of water in the process circuit is to significantly change, that a permit modification must be obtained. Although the NF concentrate stream is similar in quantity and quality to other waters permitted to be discharged to the tailings line, it has not been specifically identified as a constituent thereof. Similarly, the RO concentrate stream has not been specifically identified as a constituent of the tailings/process water circuit. Therefore, UPDES permit No. UTD0000051 must be modified to include these concentrate streams.

4.1.2 Drinking Water Source Permit

The selected remedial alternative calls for containing, extracting and treating contaminated groundwater and producing clean drinking water for consumption by local municipalities. This drinking water will be considered a new source and will comply with existing State rules for a drinking water system. Therefore, a Preliminary Evaluation Report, Source Protection Plan and drinking water permit will all be required for this part of the remedial design.

4.1.3 Groundwater Discharge Permit

The selected remedial technology utilizes membrane filtration to partition the contaminated groundwater into permeate (cleaner water) and concentrate (highly concentrated contaminated water). The NF and RO treatment facilities will be located above the contaminated aquifer, and spills will not have a significant detrimental affect to the contaminated aquifer. However, both concentrate streams will contain concentrations of contaminants higher than those found in the aquifer. Discussions with UDEQ will determine the applicability and need for a groundwater discharge permit.

4.1.4 Construction Permits

The treatment facilities to be constructed will be located on KUCC property and serviced by KUCC utilities (power, water, sewer, etc.). In many instances, construction permits are required for water treatment facilities regardless of location. A construction permit was previously obtained for the NF treatment facility, and it is anticipated that an additional construction permit will be required for the Zone A RO treatment plant.

4.1.5 Air Emissions Permit

Other than controlling fugitive dust per State rule (R307-215) during construction activities, no air emissions are anticipated that would require an air permit from the UDEQ Division of Air Quality. As the remedial design progresses, potential air emission sources will be evaluated and communicated to UDEQ to determine if a permit is required.

4.2 Institutional Controls Plan

The following draft Institutional Controls Plan has been prepared to outline the efforts needed to establish and implement the institutional controls included as part of the remedy for the site. The institutional controls that apply to this site include both access restrictions and point of use restrictions, as described below. To properly implement the use restrictions as described herein, KUCC will need the assistance of the State Engineer, EPA, and UDEQ that oversee the future use of land and water within and adjacent to the project area.

4.2.1 Access Restrictions

Access restrictions are controls or measures that will be taken to prevent or limit access to the site. For much of the KUCC site, a fence currently surrounds the perimeter of KUCC property and is patrolled by security hired by KUCC. The design submittals will include requirements to ensure that the perimeter fencing is maintained, that no trespassing signs are posted and maintained and that security continues to patrol the area.

4.2.2 Use Restrictions

Use restrictions for the site will include specific deed notifications and restrictions, groundwater use restrictions, well installation restrictions and a moratorium on new water rights.

4.2.3 Land Use Restrictions

By restricting future use of the property in the deed, the future occupant/owner will be protected from potential hazards and contaminants. Restrictions on future use also will protect drinking water source areas through a drinking water source protection plan that is required as part of the drinking water permit. Further, land use restrictions also will be designed such that the perpetual water treatment activities are not negatively affected. Such restrictions could include a restriction on the depth that footings or utilities may be placed in certain areas of the site, restrictions on excavating within areas that have been capped and possibly permanent easements though certain sections of the site. The process of implementing the deed restrictions typically involves creating a restrictive covenant that the owner of the property signs and the City or County attaches to the deed.

4.2.4 Groundwater Use Restrictions

Restrictions on the use of water from existing wells, restrictions on the installation of new wells and a moratorium on new water rights within and adjacent to the project area should be established through the State Engineer and Department of Water Resources. KUCC has already petitioned the State Engineer to implement the moratorium on new water rights that will minimize the effects of aquifer draw down related to the containment and extraction remedial strategy approved in the ROD.

5.0 DESIGN QUALITY CONTROL

This is a unique remediation project and remedial design. The containment and extraction system were designed, installed and tested during the RI/FS process. The acid extraction well was installed and successfully tested at approximately 500 gpm in conjunction with modular units of the NF Plant. The design work and much of the construction are basically complete for this part of the project. The only items left to complete are to add additional modules to the system as treatment flows are ramped up to 2500 gpm.

The containment wells for the sulfate have been in operation for several decades supplying process water to the Copperton concentrator. After the design and construction of the RO Plant, these wells will continue to be pumped, but will be routed to the RO plant rather than the concentrator. Since this system will be producing drinking water, the design and construction of this are subject to the review and approval of the UDEQ Division of Drinking Water as part of the process of obtaining a drinking water permit. To avoid duplicative oversight, it is recommended that the Division of Drinking water provide the primary review for this system as part of the overall remedial design.

QA/QC procedures will be implemented throughout the design process to ensure that the final design is technically sound, cost-effective, biddable, constructible and that the design meets the remedial action goals for the site. The following mechanisms will be used to assure that the remedial design is completed in a high quality manner.

- Criteria Committee Meetings
- Design checks at each design phase
- Operability reviews
- Constructability reviews.

Each quality check mechanism is summarized below. There are also specific procedures for checking and reviewing drawings, specifications, calculations and construction cost estimates and schedules.

5.1 Criteria Committee Meetings

Criteria Committee Meetings (CCMs) are internal (KUCC) project review meetings with both the KUCC project management team and KUCC Engineering Services. The first CCM will be held following the completion of the Remedial Design Work Plan to set appropriate criteria and directions for the work. A second CCM will be held prior to completion of the Preliminary Design to provide continued input throughout the project. The idea is to obtain input from experienced individuals at critical junctures in the remedial design. The objective of the meetings is to critically review the direction, criteria, budget and schedule of a project.

5.2 Design Checks

Design Checks are crucial to the overall success of the remedial design process and will consist of the following:

5.2.1 Preliminary Design Check

The Preliminary Design Check will be performed by KUCC or an independent third party who will review the design criteria, the preliminary monitoring plan, permit requirements, institutional control plans and check and approve drawings. This check also will review specifications, cost estimates and schedule. Following the Preliminary Design Check, the Preliminary Design will be submitted to the TRC for review.

5.2.2 95 Percent Design Check

KUCC or an independent third party will perform the 95 Percent Design Check at the point of the Draft Final Design. This check will be accomplished by having a senior person within each discipline review the calculations, specifications and drawings for that aspect of the design. This check also will review detailed construction cost estimates and schedule. The reviewer(s) will verify that design changes are technically sound and do not compromise the integrity of the project or create a potential safety hazard. After the reviewer(s) verify that any changes have been incorporated into the drawings, specifications, design analysis and cost estimate, a final check and approval of drawings will be completed. This information will then be incorporated into the draft Final Remedial Design and will be submitted to the TRC for review.

5.3 Operability Review

Following the Preliminary Design, KUCC or an independent third party will complete an operability review. The review will determine if the facilities can be operated and maintained with a reasonable level of effort, and without creating a health and safety hazard for the operators. The review will be performed by an individual with experience in the startup and/or operation of similar facilities.

5.4 Constructability Review

Following the Preliminary Design, KUCC or an independent third party will conduct a constructability review. The review will focus on the ability to execute the work described, conflicts between the specifications and drawings and the ability to complete the project within the time frame allotted.

6.0 PROGRESS MEETINGS AND REPORTS

6.1 Quarterly Progress Meetings

During the remedial design phase (and continuing through the remedial action phase), quarterly status meetings will be held with EPA and UDEQ to discuss the progress of the work. Most of the meetings will be conducted by conference call. The first meeting will be held within 90 days after the draft work plan is submitted to the TRC for review. The following findings will be covered in each meeting:

- Activities performed
- Significant findings
- Problems and corrective measures taken
- Quality assurance/quality control activities and findings
- Coordination issues impacting the work
- Significant future activities.

Minutes from the meetings will be prepared and distributed to those participating in the meeting within four weeks of the meeting.

6.2 Progress Reports

A written progress report will be prepared and submitted by KUCC to EPA and UDEQ on or by the 15 day of each month to document the activities of the previous month. The report will address the following topics:

- Progress made in relation to master schedule
- Problems identified
- Problems resolved
- Deliverables submitted
- Schedule updates
- Activities planned for the next four weeks.

6.3 TRC Meetings

TRC meetings will be on an as-needed basis (likely semi-annually) to discuss the progress of the project or to discuss significant changes in scope to the project. At this time the next TRC meeting is scheduled for October 2001 to discuss the Preliminary Design and submit the design to the TRC for review.

7.0 SCHEDULE FOR REMEDIAL DESIGN ACTIVITIES

7.1 Summary of Deliverables

A list of various deliverables to be submitted during the remedial design phase is shown on Table 7-1. A reference is included to direct the reader to the respective section of this RDWP where the deliverable is discussed in detail.

Two bound copies of each deliverable will be submitted to EPA and UDEQ. One copy of various deliverables will be submitted to specific members of the TRC based upon area of oversight and expertise.

7.2 Schedule

The schedule for completing the scope of work delineated in this RDWP is shown in Figure 7-1. To provide an overall picture of the time frame required to implement the remedy, a preliminary schedule for field activities assumes that favorable weather conditions will exist at the time of work. If this is not the case, the schedule will need to slip to accommodate weather conditions.

The schedule shown in Figure 7-1 is aggressive and optimistic. A concerted effort by all parties will be necessary to meet the deadlines shown. This will entail frequent communication to discuss progress on deliverables and major issues, making sure that the first drafts of documents are a complete as possible, focused reviews by agencies and their consultants, and potentially reducing the number of design submittals. In addition to these efforts, it also will be necessary to prioritize the various deliverables and allow those designated as a lower priority to slip until after the critical path deliverables are complete. The color-coding of the tasks shown in Figure 7-1 indicates which items are considered critical path tasks, secondary priority and tertiary priority. As the project progresses, the priorities will be revisited and, if necessary, the schedule will be revised to assure that the critical path tasks are being given the highest priority.

8.0 REFERENCES

Dames and Moore, 1988, Milestone report I, data base synthesis: mathematical model of groundwater conditions, southwestern Salt Lake County, Utah: Contractor report to Kennecott Utah Copper, May, 64 p.

Freeze, R.A. and Cherry, J.A., 1979, Groundwater: Englewood Cliff, N.J., Prentice Hall, Inc., 604 p.

Hely, A.G., Mower, R.W., and Harr, C.A., 1971, Water resources of salt lake County, Utah: State of Utah Department of Natural Resources Technical Publication No. 31.

Kennecott Utah Copper (KUC), 1998a, Final draft remedial investigation report for Kennecott Utah Copper south facilities groundwater plume, southwest Jordan Valley, Utah. Version B, March, 1988, variously paged.

Kennecott Utah Copper (KUC), 1998b, Final draft feasibility study report for Kennecott Utah Copper south facilities groundwater plume, southwest Jordan Valley, Utah. Version B, March, 1988, variously paged.

Lambert, P.M., 1995, Numerical simulation of ground-water flow in basin-fill material in Salt Lake Valley, Utah: Utah Department of Natural Resources Technical Publication No. 110-B, 58 p.

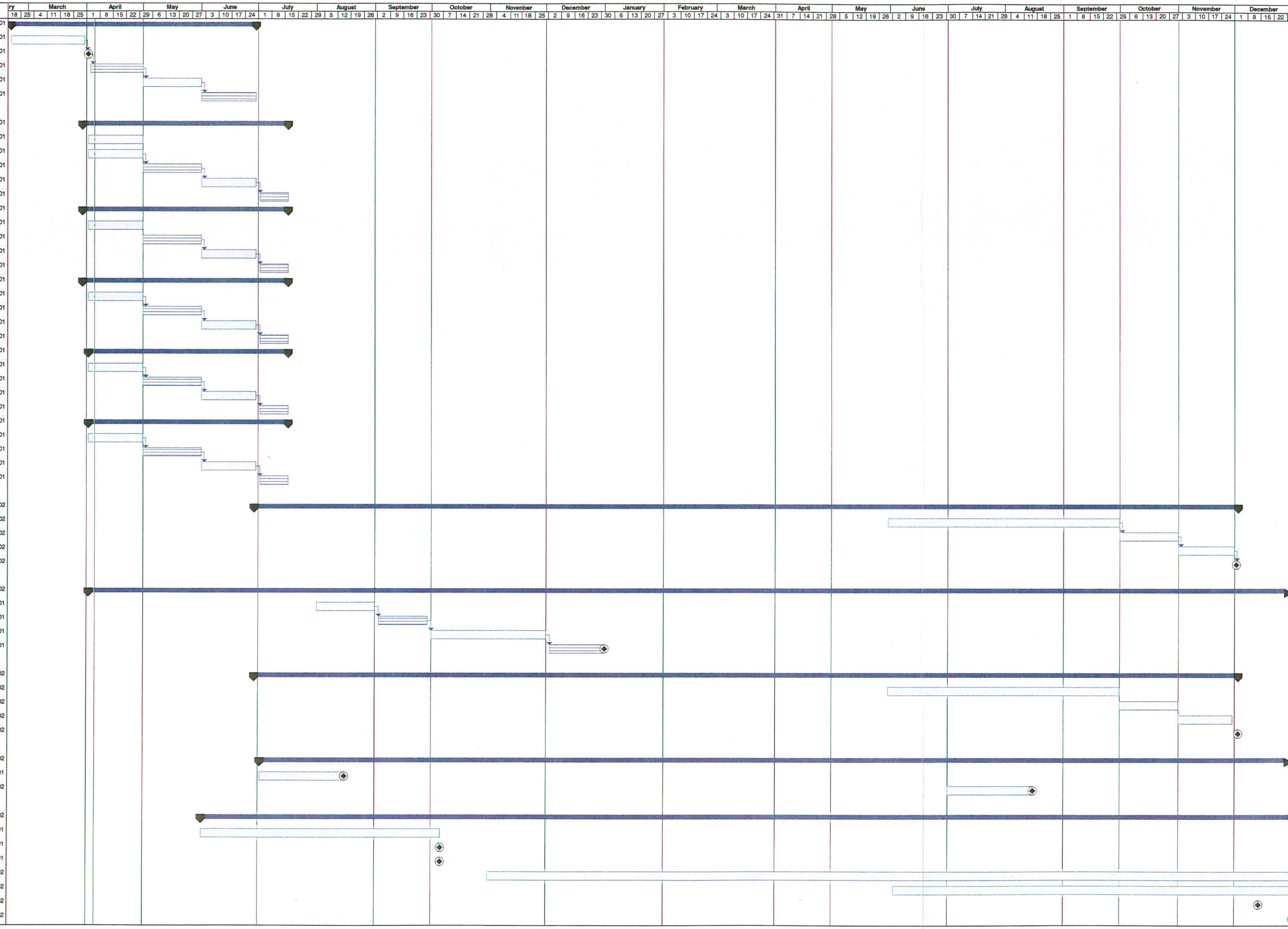
Shepherd Miller, Inc. (SMI), 1996, Estimates of background concentrations of metals and non-metals in groundwater, southwestern Jordan Valley, Utah: Contractor report to Kennecott Utah Copper Corporation, December, 34 p. [Also Appendix B of KUC, 1998a]

Solomon, D.K. and Bowman, J.R., 1997, Stable and radioactive isotopes as tracers of groundwater and solute transport, SWJV, Utah: Contractor report to Kennecott Utah Copper Corporation, June, 37 p. [Also Appendix K of KUC, 1998a]

9.0 Table 7-1 SUMMARY OF REMEDIAL DESIGN PHASE DELIVERABLES

Document Name	Section Reference Number
Draft Remedial Design Work Plan	1.1
Final Remedial Design Work Plan	1.1
Draft Data and Records Management Plan	3.4
Final Data and Records Management Plan	3.4
Draft Work Plan for Tailings Geochem Study	3.1.2.3
Final Work Plan for Tailings Geochem Study	3.1.2.3
Draft Work Plan for Groundwater Study	3.1.2.1
Final Work Plan for Groundwater Study	3.1.2.1
Draft Groundwater Monitoring Plan	3.5
Final Groundwater Monitoring Plan	3.5
Draft Water Treatment Plan	3.1.2.2 and 3.1.2.3
Final Water Treatment Plan	3.1.2.2 and 3.1.2.3
Draft Report for Tailings Geochem Study	3.1.3.3
Final Report for Tailings Geochem Study	3.1.3.3
Draft Report for Groundwater Study	3.1.2.1
Final Report for Groundwater Study	3.1.2.1
Annual Groundwater Monitoring Report (2Q01)	3.5
Annual Groundwater Monitoring Report (2Q02)	3.5
Draft Report for Water Treatment	3.1.2.2 and 3.1.2.3
Final Report for Water Treatment	3.1.2.2 and 3.1.2.3
Preliminary Remedial Design	5.2.1
Final Remedial Design	5.2.2

ID	Task Name	Duration	Start	Finish
1	**Prepare Remedial Design Work Plan**	94d	Tue 2/20/01	Fri 6/29/01
2	Prepare Draft RDWP	29d	Tue 2/20/01	Fri 3/30/01
3	Submit Draft RDWP to TRC	1d	Mon 4/2/01	Mon 4/2/01
4	Comments on Draft RDWP due Apr 30	20d	Tue 4/3/01	Mon 4/30/01
5	Prepare and Submit Final RDWP	23d	Tue 5/1/01	Thu 5/31/01
6	Agency Review/Approval of Final RDWP	21d	Fri 6/1/01	Fri 6/29/01
7				
8	**Other Management/Work Plans**	77d	Fri 3/30/01	Mon 7/16/01
9	**Prepare Data and Records Management Plan**	21d	Mon 4/2/01	Mon 4/30/01
10	Prepare Draft Draft DRMP	21d	Mon 4/2/01	Mon 4/30/01
11	Submit Draft DRMP for Agency Review	23d	Tue 5/1/01	Thu 5/31/01
12	Prepare Final DRMP	21d	Fri 6/1/01	Fri 6/29/01
13	Agency Review/Approval of Final DRMP	11d	Mon 7/2/01	Mon 7/16/01
14	**Prepare Work Plan for Tailings Geochem Study**	77d	Fri 3/30/01	Mon 7/16/01
15	Prepare Draft Work Plan for Tailings Geochem Study	21d	Mon 4/2/01	Mon 4/30/01
16	Submit Draft Work Plan for Agency Review	23d	Tue 5/1/01	Thu 5/31/01
17	Prepare Final Work Plan for Tailings Geochem Study	21d	Fri 6/1/01	Fri 6/29/01
18	Agency Review/Approval of Final Work Plan for Tailings Geochem Study	11d	Mon 7/2/01	Mon 7/16/01
19	**Prepare Work Plan for Groundwater Studies**	77d	Fri 3/30/01	Mon 7/16/01
20	Prepare Draft Work Plan for Groundwater Studies	21d	Mon 4/2/01	Mon 4/30/01
21	Submit Draft Work Plan for Agency Review	23d	Tue 5/1/01	Thu 5/31/01
22	Prepare Final Work Plan for Groundwater Studies	21d	Fri 6/1/01	Fri 6/29/01
23	Agency Review/Approval of Final Work Plan for Groundwater Studies	11d	Mon 7/2/01	Mon 7/16/01
24	**Prepare Draft Groundwater Monitoring Plan**	76d	Mon 4/2/01	Mon 7/16/01
25	Prepare Draft Groundwater Monitoring Plan	21d	Mon 4/2/01	Mon 4/30/01
26	Submit Draft Groundwater Monitoring Plan for Agency Review	23d	Tue 5/1/01	Thu 5/31/01
27	Prepare Final Groundwater Monitoring Plan	21d	Fri 6/1/01	Fri 6/29/01
28	Agency Review/Approval of Final Groundwater Monitoring Plan	11d	Mon 7/2/01	Mon 7/16/01
29	**Prepare Water Treatment Plan**	76d	Mon 4/2/01	Mon 7/16/01
30	Prepare Draft Water Treatment Plan	21d	Mon 4/2/01	Mon 4/30/01
31	Submit Draft Water Treatment Plan for Agency Review	23d	Tue 5/1/01	Thu 5/31/01
32	Prepare Final Water Treatment Plan	21d	Fri 6/1/01	Fri 6/29/01
33	Agency Review/Approval of Final Water Treatment Plan	11d	Mon 7/2/01	Mon 7/16/01
34				
35	**Execute Tailings Geochem Study**	372d	Fri 6/29/01	Mon 12/2/02
36	Prepare Draft Tailings Geochem Study Report	87d	Fri 5/31/02	Mon 9/30/02
37	Submit Draft Tailings Geochem Study Report for Agency Review	23d	Tue 10/1/02	Thu 10/31/02
38	Prepare Final Tailings Geochem Study Report	21d	Fri 11/1/02	Sat 11/30/02
39	Submit Final Tailings Geochem Study Report to TRC	1d	Mon 12/2/02	Mon 12/2/02
40				
41	**Execute Groundwater Studies**	457d	Mon 4/2/01	Tue 12/31/02
42	Prepare Draft Groundwater Studies Report	23d	Wed 8/1/01	Fri 8/31/01
43	Submit Draft Groundwater Studies Report for Agency Review	20d	Mon 9/3/01	Fri 9/28/01
44	Prepare Final Groundwater Studies Report	45d	Mon 10/1/01	Fri 11/30/01
45	Submit Final Groundwater Studies Report to TRC	21d	Mon 12/3/01	Mon 12/31/01
46				
47	**Execute Water Treatment Studies**	372d	Fri 6/29/01	Mon 12/2/02
48	Prepare Draft Water Treatment Study Report	87d	Fri 5/31/02	Mon 9/30/02
49	Submit Draft Water Treatment Study Report for Agency Review	23d	Tue 10/1/02	Thu 10/31/02
50	Prepare Final Water Treatment Study Report	21d	Fri 11/1/02	Fri 11/29/02
51	Submit Final Water Treatment Study Report to TRC	1d	Mon 12/2/02	Mon 12/2/02
52				
53	**Execute Groundwater Monitoring Plan**	392d	Mon 7/2/01	Tue 12/31/02
54	Prepare and Submit Annual Reports following 2Q of Each Year	33d	Mon 7/2/01	Wed 8/15/01
55	Prepare and Submit Annual Reports following 2Q of Each Year	34d	Mon 7/1/02	Thu 8/15/02
56				
57	**Prepare Design Submittals**	413d	Fri 6/1/01	Tue 12/31/02
58	Prepare Preliminary Design Submittal	91d	Fri 6/1/01	Fri 10/5/01
59	Preliminary Design TRC Meeting	1d	Fri 10/5/01	Fri 10/5/01
60	Submit Preliminary Design to TRC	1d	Fri 10/5/01	Fri 10/5/01
61	Obtain Required Permits	305d	Wed 10/31/01	Tue 12/31/02
62	Prepare Final Design Submittal	152d	Mon 6/3/02	Tue 12/31/02
63	Final Design TRC Meeting	1d	Fri 12/13/02	Fri 12/13/02
64	Submit Final Design to TRC	1d	Tue 12/31/02	Tue 12/31/02



Project: SOUTH FACILITIES RDWP
Date: Thu 4/5/01

FIGURE 7-1

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Figure 7-1

Attachment A
TECHNICAL MEMORANDUM

DATE: 05 April 20001

TO: **Jon Cherry (KUCC)**

FROM: Mark J. Logsdon (Geochimica)

SUBJECT: GEOCHEMICAL IMPACTS OF TREATED WATERS FROM KUCC SOUTH FACILITIES ON THE NORTH TAILINGS IMPOUNDMENT, KENNECOTT UTAH COPPER CORPORATION, MAGNA, UTAH

PURPOSE AND OBJECTIVES

The purpose of this memorandum is to propose a scope of work that will be performed. The work that is the subject of this proposal will be the geochemical and hydro-geochemical portions of the investigations needed to finalize technical aspects of the tailings-system disposal plans as part of the Remedial Design/Remedial Action (RD/RA) programs.

Specific objectives of the memorandum include:

- Identification of the general scope and technical approach to the proposed geochemical studies
- Identification of a general scope of work for the geochemical investigations.

GENERAL SCOPE

The general scope of the studies would be the geochemistry and hydrogeochemistry of the disposal system for the Zone A treatment fluids (i.e., concentrates from both the NF and the Zone A RO units) in the Copperton tailings line and the North Impoundment tailings facility. The work will address the: (1) specific geochemical and/or physical mechanisms of metals removal in the tailings circuit; (2) full-scale addition of the groundwater treatment streams to the tailings circuit for different scenarios of mine planning; and (3) short- and long-term geochemical stability of the metals from this waste stream in the tailings environment. Alternatives to tailings-system disposal (i.e., to address post-mining water management) will be addressed in a separate scope of work.

Evaluation of the tailings-disposal option will use work prepared primarily by others that describes the systems that (a) collect and transmit groundwater and meteoric leach water, (b) treat the collected waters through nanofiltration and reverse-osmosis treatment processes, and (c) manage the tailings production, disposal and reclaim aspects of the system.

It is expected that the products will include quantitative models of the disposal system that can be used by KUCC in long-term planning and in the development and implementation of monitoring programs.

TECHNICAL APPROACH

The technical approach to the study is expected to include the following elements:

1. **Description of the existing system and its planned enhancements.** This would include descriptions and critical evaluations of (a) the hydrogeochemical origin and existing conditions for groundwater and wastedump draindown; (b) the technical basis for estimating future flows and chemistries of ground-water and meteoric-leach solutions; (c) the tailings disposal system (including its miscellaneous inputs and outputs); (d) the design-basis wastewater treatment systems.

2. **Documentation of the hydraulic design and performance of the Copperton tailings line and any other piped systems and reservoirs that are needed to define the total flow system for the tailings disposal system**. The goal of this documentation will be to develop the conceptual model for the engineered disposal system as a chemical reactor (or as a system of coupled reactors). For example, it may be possible to describe the Copperton tailings line as a plug-reactor system with dispersion, chemical reaction (for some components), and feedback (via the decant return line system). Because both the water-treatment concentrates and the tailings slurry inputs are expected to vary in terms of volume and chemistry over time, the model will have to be developed in terms of transient conditions.

3. **Characterization of the general flow field(s) in the tailings system,** including the pipeline reactor and both the unsaturated and saturated portions of the North Impoundment.

4. **Description of the mineralogy of tailings and chemistry of tailings slurry.** The tailings mineralogy will include both the ex-concentrator tailings (probably a time-variant function of ores) and the secondary changes to tailings minerals that occur over time in the disposal system (e.g., pipeline scale and tailings mineralogy as a function of location and time in the impoundment, based on oxidation and other weathering reactions and KUCC changes to the system such as direct lime addition). The tailings-slurry chemistry will be extended to characterizing the pore-water chemistry of the tailings in the North Impoundment, as functions of both location (x,y,z) and time as well as primary mineralogy.

5. ***<u>Determination of the hydrogeochemical mechanisms responsible for changes in</u>*** <u>chemistry</u> of (a) tailings slurry in the Copperton line; (b) decant solutions; (c) tailings pore-water in the impoundment; and (d) mineralogy and surface chemistry of tailings solids.

6. **Development of a quantitative model for the geochemical evolution of the tailings system** as a function of (a) inputs to the tailings line at the concentrator; (b) processes in the tailings line; (c) processes in the tailings impoundment; and (d) feedback to the tailings-line inputs from decant solutions and miscellaneous KUCC flows that report to the process ponds. The modeling, in conjunction with other studies, will address the long-term geochemical stability of metals and metalloids in the North Impoundment system.

GENERALIZED SCOPE OF WORK

Task 1. Compile existing databases and other information on groundwater hydrology and chemistry, tailings chemistry and mineralogy, mine planning, water treatment, and physical and chemical performance of the tailings system.

Task 2. Document and evaluate the existing groundwater flow and transport model(s) and the existing mass-balance model(s) for the tailings circuit.

Task 3. Develop (or elaborate) a conceptual model for the tailings-disposal system. The conceptual model should be carried through to an initial identification of the constitutive relationships that would be part of a mathematical model and the identification of methods to solve the mathematical relationships.

Task 4. Review the existing sampling and analysis plan for tailings and process-water system and modify as necessary to account for: (a) tailings mineralogy and geochemistry (including the mineralogy and geochemistry of scale formation in pipelines); (b) tailings slurry solutions and other liquid inputs to the tailings pipelines; (c) pore water in both saturated and vadose zones of the North Impoundment; (d) decant solutions; (e) tailings solids in the saturated and vadose zones; and (f) hydraulic parameters for the saturated and vadose zones.

Task 5. Analyze the tailings system hydraulics including (a) flow in pipelines (b) hydraulic conditions and processes in the saturated zone(s) (c) hydraulic conditions and processes in the vadose zone and (d) fluid recycling.

Task 6. Examine the mineralogy and geochemistry of tailings solids and pipeline scale.

Task 7. Analyze the chemistry of solutions.

Task 8. Evaluate geochemical mechanisms for fluid and solid changes.

Task 9. Develop and calibrate one or more quantitative models for the geochemical evolution of fluids and solids in the tailings system as a function of operational conditions and time (which will extend beyond the period of active mining).

Task 10. Prepare reports.